Performance Comparison of Long-Distance Helium Pulsating Heat Pipes with Varying Adiabatic Lengths

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Helium pulsating heat pipes (PHPs) are an emergent heat transfer technology with the potential to provide efficient, long-distance cooling power for numerous low-temperature technologies, such as superconducting magnets and space telescopes. In addition, helium PHPs are especially valuable as an enabling component for cryocooler utilization in that they can readily transfer the localized cooling power from the tip of a regenerative cooler over long distances to a variety of heat loads. In this study, an experimental facility is developed to test the performance of vertically oriented, large-scale helium pulsating heat pipes with adiabatic lengths up to 1.75 m. The PHPs consist of 14 parallel stainless-steel tubes with an inner diameter of 0.5 mm, approximately the diameter required to maintain a plug-slug flow regime via capillary forces. Each end of the pulsating heat pipe is fixed to a thin copper plate where the condenser end is cooled by a 4 K cryocooler with a 1.5 W cooling capacity, while a resistive heater provides a prescribed heat load to the evaporator end. Motivated by previous experimental results where helium PHPs displayed a constant conductance despite an increasing adiabatic length, these experiments aim to characterize the length-independence of helium PHPs by evaluating the performance of PHPs with adiabatic lengths longer than 1 m. Preliminary results show that a helium pulsating heat pipe with an adiabatic length of 1.25 m can operate steadily with effective conductivities over 100 kW/m-K.